Research Journal of Finance and Accounting
ISSN 2222-1697 (Paper) ISSN 2222-2847 (Online)
Vol 3, No 6, 2012

The Structural Analysis of Green Innovation (GI) and Green Performance (GP) in Malaysian Automotive Industry

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The research is financed by Fundamental Research Grant Scheme (FRGS) no. 2011-0071-106-02, and UPSI Research University Grant (RUG).

Abstract

Green innovation is increasingly implemented in the automotive industry. The aim of this study is to review and structural relationship analysis of green innovation and green performance. A set of assessment measurement of strategy propose green performance is expected to be suitable to their innovation characteristics and improve their green performance. Thus, the aim of this study is to investigate the relationship between green innovation and green performance in Malaysian automotive industry. The conceptual model using Structural Equation Modeling (SEM) has been proposed. Based on the proposed conceptual model and reviewed, research hypotheses are being developed. The paper culminates with suggested future research work.

Keywords: Green innovation, Green performance, Environmental management, Structural equation modeling, Automotive

1. Background of the study

The automotive industry is one of the industries that have visibly suffered a strong demand for higher environmental performance. In the 21st century, many companies or manufacturing process give more emphasis into innovation. Innovations carried out predominantly driven by focus on the products and processes to create a more simple system and in time it can provide lower cost, as well as to respond to save the environment and social responsibility. Therefore, if the automotive industries in Malaysia want to improve their Green Performance (GP) and in the same time increase the company's competitiveness, they need to involve their activities with emphasis on innovation, especially in products and processes.

Green Innovation (GI) refers to innovations that are applied in products and processes that bring the automotive industry to leads to higher levels of the environmental sustainability. According to Chen *et al.,* (2006), GI is defined as hardware or software innovation that is related to green products or processes, including the innovation in technologies that are involved in energy-saving, pollution-prevention, waste recycling, green product design or corporate competitive management. Therefore, GI can be defined as a method to identify, implement and monitor the new ideas that have a positive impact on the environment and increase the company's competitiveness.

GI classified into three items as green product and green process and green managerial innovation in order to increased environmental performance (Chiou *et al.,* 2011). For example, Chen (2008) found that GI (green product innovation and green process innovation) are positively effect on competitive advantage. This also support by Rao (2002) with identified that green practices implementation are lead to improve GI. Thus, we believe by exploring the green practices, GI will be benefit toward automotive industries in order to improve GP.

Consistent with earlier studies, GI is more becoming increasingly important for companies to raise their environmental awareness because more and more international customers and buyers are requiring their suppliers to produce products that do not contain hazardous and toxic substances (Chiou *et al.,* 2011). They also opinionated that

identification includes not only the understanding of environmental demands but also customer's requirements and acceptance of environmentally-friendly products, competitors' actions, amongst other factors that need to be considered in the innovation of product or process. According to Nunes and Bennett (2008), implementation of GI refers to the development of the idea in the market and finally, monitoring is the activity that should feedback the company about its GI in order to enhance the learning of innovating in sustainable way.

Nowadays, environmental management and innovation are predicted to be the most important performance indicators for the competitive advantage of firms in the future. A set of assessment measurement of GP is expected to be suitable to their innovation characteristics and improve their GP. According to Brunnermeier and Cohen (2003), they found that some empirical evidence that GI more likely to occur in industries that are internationally competitive. Based on earlier researched, GI is increasingly implemented in the automotive industry in other countries. But, automotive industry in Malaysia is still a lack of emphasis on GI. Therefore, the aim of this study is to investigate and structural analysis the GI and GP especially in Malaysia. Thus, the aim of this study is to investigate the relationship between GI and GP in Malaysian automotive industry.

2. Literature Review of Green Innovation (GI) Implementation and Green Performance (GP) in the Malaysian Automotive Industry

The environmental damage, resulting from the industrial activities since the industrial revolution, is a serious global problem in the world. In order to decrease the environmental pollution, the concept of green management such as green production and GI are advocated. In automotive industry, GI particularly in product and their process are more important to improve their GP to decrease the environmental pollutions.

Referred to the previous studies, the companies can differentiate their products, improve product quality and lower the cost of production through product and process innovations (Chiou, 2011). He also suggested that to bridge this gap by providing empirical evidence to encourage companies to implement GI in order to improve their environmental performance and to enhance their competitive advantage in the global market. According to Chen *et al.,* (2006), they also found that the intervening variables of green product innovation and green process innovation contribute to decrease environmental pollution and improvement their competitive advantage.

More specifically, GI are the focal constructs in the theorized model with internal environmental Green Product Innovation (GPTI) and Green Process Innovation (GPSI) as antecedents and environmental, economic, operational and innovation performance as consequences. Definitions of the constructs of GI incorporated in Table 1.

2.1 Green Product Innovation and Green Process Innovation

2.1.1 Green Product Innovation (GPTI)

According to Sanchez and Mckinley (1998) that environmental regulation has a specific effect on product innovation, mediated through transformations in production processes. Meanwhile, GPTI which is besides benefits have improvement on green performance benefits especially for the customer (e.g energy saving) will generate stronger consumer demand and can increase the company's motivation to implement those innovations in the first their management (Kammerer, 2009). Huang and Wu (2010) also found that corporate environmental commitment, environmental benchmarking, R& D strength, and cross-functional integration are contributed on GPTI, and their finding showed that GPTI had a positive influence on green performance.

2.1.2 Green Process Innovation (GPSI)

GPSI included all innovations that have a beneficial effect on the environment of whether this effect was the main objective of the innovation. According to Bernauer *et. al.,* (2006), GPSI is defined as improvements in the production process resulting in reduced environmental impacts. GPSI is more to process that involved totally in new methods that can contribute to environmental protection or a more efficient use of resources (Chen *et al.,* 2008). Thus, when focusing on GPSI, companies or manufacturers will gain cost savings, increased efficiency, increased productivity and better product quality, and also all leading to improve their GP (Chiou, 2011).

2.2 The Positive Effect of Green Innovation (GI) on Green Performance (GP)

Recent studies have begun to systematically explore the relationship between GI and GP. According to Chen and Chang (2011), they found that GP has the nonlinear effect on the corporate competitive advantage. Thus, they suggested that if companies hope to enhance their competitive advantages through GI, they must check their GP. Study by Theyel (2000), stated that adoption of several integrating environmental particularly in firm's innovation will improving their GP in order to achieve competitive advantage. Similar study by Brio and Junquera (2003), they found that focusing on GI actions from turning into a competitive advantage for company and on the other hand, it will increase GP levels similar to those of larger companies.

There are many studies proven that implementation of GI given positively results especially in manufacturing process. Generally, the qualitative and quantitative impacts of GI give more potential benefits of GP (Carrion- Flores and Innes, 2010). According to findings by Eiadat *et. al.,* (2008) that GI strategy and company's positive GP are positively linked and should consequently continue to search for win-win solutions to their environmental problems. As viewed a whole studies, there might be different GI that it can indicate in different GP improvements. Thereby, these study separately in different GP measures such as environmental, economic, operational and innovation performance as consequences for this study. There for, below shows definitions of GP measure incorporated in Table 2.

2.3 The Research Framework of the Study and Hypotheses Development

The research framework is shown in Figure 1. The research framework of this study has suggested that GI is thought to improve GP in Malaysian automotive industry. This regulation is also thought to impact upon the levels of GI in an industry. When viewed as a whole on previous studies are as decisive in saying that there is a relationship between GI and GP. Therefore, based on the literature review and the research framework, the following hypotheses of the study have been developed:

> **H_1:** There is a positive and direct significant relationship between GI and GP in Malaysian automotive industry

To understand the relationship of GI on GP in Malaysian industry, the hypotheses above were set up to be tested. These hypotheses will be stated based on a numbering system from H1. This style of hypothesis statement is chosen due to the nature of answering hypotheses using SEM methods.

3. A Proposed Research Model

SEM not only estimates multiple interrelated relationships but also has the ability to incorporate latent constructs into an analysis. Based on comprehensive review of previous study, a latent construct cannot be measured directly but can be approximated by observed or measured variable. The measured variables are obtained from respondents in response to a set of questionnaire. The research model aims at analyzing the impact of the relationship between GI and GP for Malaysian automotive industries. This model is called mediating model as presented in Figure 2.

4. Methodology

Automotive industries were chosen because the use of quality initiative and performance measurement in this sector is very important (Zakuan *et al.,* 2009). It is an important industrial driver of industrial management and development, because it brings together various components, which are manufactured by suppliers in other industries (Chin and Saman, 2004). In this study, sampling method by using structured questionnaire. The population of this study comprised in Malaysian automotive industry. Having said that, the sample should be a subset of the total population, which has the characteristics of the population. In this study, samples were selected from the list of PROTON and PERODUA automotive suppliers. In achieving the objectives of the study, the Malaysian automotive suppliers firms were selected as the population and the data was obtained from PROTON Vendor Association (PVA) and Kelab Vendor PERODUA (KVP). These lists of automotive suppliers consist of electrical, electronic, metal, plastic, rubber, and other automotive part.

SEM techniques was utilize to perform the require statistical analysis of the data from the survey. Exploratory factor analysis, reliability analysis and confirmatory factor analysis to test for construct validity, reliability, and

measurements loading were performed. Having analyzed the measurement model, the structural model was then tested and confirmed. The statistical Package for the Social Sciences (SPSS) version 17 was used to analyze the preliminary data and provide descriptive analyses about thesis sample such as means, standard deviations, and frequencies. Structural Equation Modeling (SEM using AMOS 6.0) will use to test the measurement model.

5. Conclusion

GI and GP has become most important of green initiatives and it involves local car manufacturers and automotive suppliers in their effort to become more environmentally effective and competitive in pursuing to enhance the organization ability to improve GI, technology development, and GP. This study expected to provide valid and reliable for instrument and structural relationship model for GI constructs and GP measures. Many studies have been performed to identify critical success factors for successful implementation of GI. However, no previous study had tried to investigate the relationships between GI and GP, especially in Malaysian automotive industry. A conceptual model has been proposed to examine the relationships between GI and GP in the automotive industry in Malaysia. Based on proposed model and a previous study, research hypotheses are being developed. The next step of this study is to design a questionnare, which will be used for pilot study data collection in automotive industry in Malaysia.

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Table 1. Construct definitions

Construct	Operational definition
Green Product Innovation (GPTI)	Product that is related to environmental innovation, including the innovation in product that are new or that offer a significant improvement on the basic characteristic, technical specification, incorporated software or any components or materials and the product that introduced are involved in energy-saving, pollution-prevention, waste recycling, no toxicity, or green product design, using less or non-polluting/ toxic materials, improving and designing environmentally friendly packaging for existing and new products, recovery of company's end-of-life products and recycling (Chen *et al.,* 2006; Santamaria *et. al.,* 2012; Brunnermeier and Cohen, 2003; Chiou *et al.,* 2011; Huang and Wu, 2010)
Green Process Innovation (GPSI)	Process that assumed to happen when it has implemented new or significantly improved production processes, distribution new methods or support activities for its good and services and the process is related to energy-saving, pollution- prevention, waste recycling, or no toxicity, low energy consumption, recycle, reuse and remanufacture material and use of cleaner technology to make savings and prevent pollution (Chen *et al.,* 2006; Santamaria *et. al.,* 2012; Brunnermeier and Cohen, 2003; Chiou *et al.,* 2011)

Table 2. Measure of green performance

Measure	Definition
Environmental Performance	Environmental performance relates the ability of manufacturing plants to reduce air emissions, effluent waste, and solid wastes and the ability to decrease consumption of hazardous and toxic materials (Zhu *et al.,* 2008; Wagner *et al.,* 2001; Zhu and Sarkis, 2004; Chien and Shih, 2007: Montabon *et al.,* 2007; Chiou *et. al.,* 2011).
Economic Performance	Economic performance relates to the manufacturing plant's ability to reduce costs associated with purchased materials, energy consumption, waste treatment, waste discharge, and fines for environmental accidents (Zhu *et al.,* 2008; Wagner *et al.,* 2001; Zhu and Sarkis, 2004).
Operational Performance	Operational performance relates to the manufacturing plant's capabilities to more efficiently produce and deliver products to customers (Zhu *et al.,* 2008; Chien and Shih, 2007).
Innovation Performance	Innovation performance can defined as measures of green innovation in develop new ideas and behavior to produce product and processes and at the same time can contribute to a reduction of environmental burdens (Wagner, 2008; Montabon, *et al.,* 2007; Rennings, 2000).

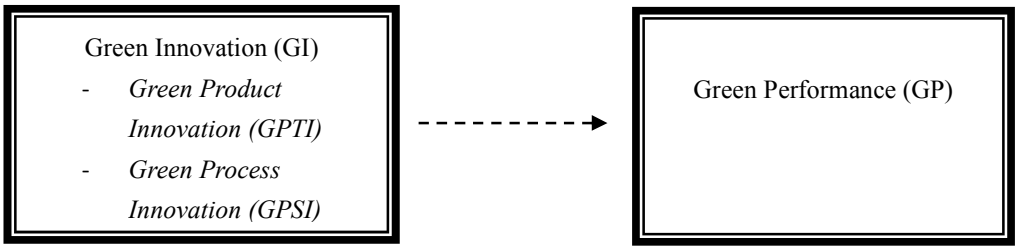
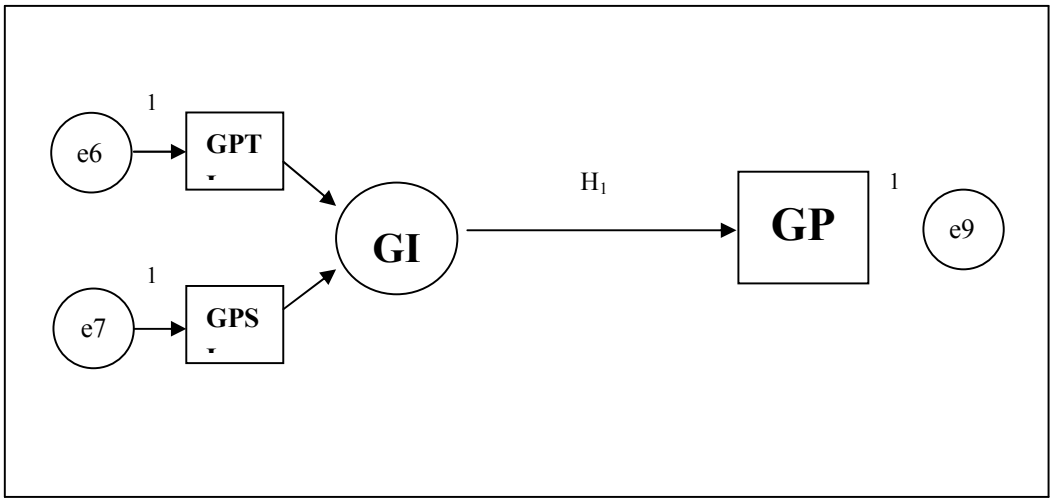


Figure 1. Research Framework



*Note: GI= Green Innovation, GP=Green Performance, GPTI=Green Product Innovation, GPSI= Green Process Innovation.

Figure 2. Model of the Study